

Department of Behavioral Sciences and Leadership

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**Posttraumatic Outcomes and a New Method to Diagnose and Monitor
Patients through MEG**

Authors

David G. Johnson

Tyrell A. Thompson

Lolita M. Burrell

Michael D. Matthews

United States Military Academy

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ABSTRACT

From 2003 to 2008, there were 40,000 cases of PTSD reported among Soldiers. This psychiatric disorder can affect Soldiers behaviorally, biologically, and neurologically. However, PTSD is not the only reaction of Soldiers to traumatic events. Research shows that positive outcomes are a more common reaction to traumatic events. Posttraumatic growth and the increase of resilience in Soldiers have been reported in many cases. Currently the Army is seeking new ways to diagnose PTSD as well as measure the effectiveness of the interventions put forth to treat it. MEG data along with bootstrap analysis gives researchers the ability to objectively diagnose PTSD and the success of interventions. If the severity of PTSD predictions can be better refined through such measurement, this may provide objective evidence as to whether or not certain interventions are actually improving a Soldier's mental health.

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Introduction

As more service men and women are exposed to combat, the potential for developing posttraumatic stress disorder (PTSD) has increased. From 2003 to 2008, there were 40,000 cases of PTSD (CBS News, 2008). Although there are a growing number of cases in the services, there are also personnel in the military that are not victims of PTSD, but in fact may even benefit from traumatic events. Many positive psychology studies show the positive effects of high stress on Soldiers. Factors such as morality salience, hardiness, and grit have been shown to have a positive effect on the responses that Soldiers display in high stress environments.

An example of a high stress environment is deployment to a war zone. There is the stress of being away from a Soldier's loved one, in addition to the stresses of everyday work, mixed with the extreme stress of being placed in a combat environment. Hardiness protects against the ill effects of stress under particularly high and multiple stress conditions (Bartone 1999). Bartone's (1999) study was conducted on male veterans to record the effects of the high stresses of war. The participants of this study were 1,287 veterans from World War II, Korea, and Vietnam. The results were that more desirable effects were reported from the veterans than undesirable ones. Some of these desirable effects included mastery, increased self-esteem, and positive coping skills. The most desired outcome for the military is for all Soldiers to develop resilience to stress, especially the type of stress Soldiers will face during deployments. Ritchie et al. (2008) defines resilience as, "the ability to adjust easily to stress or to recover quickly and effectively from exposure to stress."

Studies of positive psychology and resilience are done for two main reasons. The first reason is that it is important to study the full scope of the effects of stress. The field of psychology places a large emphasis on the negative components of stress and the causes for disorders such as PTSD. However, looking at the positive effects of stress will help researchers, clinicians, and leaders gain a better understanding of the potential benefits for Soldiers. The second reason is that by studying the positive effects of stress, hopefully proactive measures can help Soldiers adaptively cope with the stresses of deployment. The ultimate goal is not to find another way to treat PTSD, but find ways to create and evaluate methods to increase the resilience of all Soldiers.

Purpose

Currently, the ability to increase or measure resilience in Soldiers is limited. With the growing number of PTSD cases this becomes a problem that can take service members out of the fight just like an injury. The goal of programs like Comprehensive Soldier Fitness (CSF) is to enable Soldiers to be more resilient to the effects of stress and traumatic events. Between 2003 and 2004 alone, Hoge, Auchterlonie, and Miliken (2006) found that 19.1% of those who served in Iraq, 11.3% of those who served in Afghanistan, and 8.5% of those who served in other areas reported mental health problems when they returned. That is almost 20% of the force serving in Iraq that may have been ineffective in combat and may not be able to return for subsequent tours. If resilience training and screening can be implemented into the Army, these interventions may be able to prevent Soldiers from developing PTSD. The goal of this paper is to examine the effects of stress on the human body, investigate both positive and negative outcomes of sustained stress, and present a physiological method of classifying PTSD

that may be used to measure the effectiveness of interventions implemented to prevent PTSD.

Stress and Traumatic Events

Soldiers exposed to a traumatic event and high stress may experience one of three major outcomes. The first is the development of PTSD. The second, which has only lately been researched, is post traumatic growth (PTG). PTG refers to positive psychological change experienced as a result of the struggle with highly challenging life circumstances (Calhoun & Tedeschi, 1999, 2000). The last outcome a Soldier may experience due to high levels of stress or a traumatic event is resilience.

Many models attempt to predict the behavior of a person under stress. One model, the four processes stress model involves four steps regarding a person's response to a stressor or stressful situation (McGrath, 1976). The first stage of responding to stress is appraisal. The person will first appraise or assess the situation and decide if the situation will be undesirable if the situation is left unattended. The individual will then think about and select a course of action that will decrease the negative effects of the situation. Once the course of action is selected, the individual will execute the course of action they have chosen. Finally, the individual will assess the effect of this course of action. The person will evaluate the course of action based on the realistic effect of the action on the situation and the person's ability to perform the action.

PTSD can be experienced in many different fashions when a traumatic event occurs. When Soldiers, or any individual for that matter, experience a major life crisis they usually experience highly distressing emotions. When the event is one in which the person's life or physical well-being is in danger, the person often feels fear and anxiety.

If the intensity, severity, and duration of the threat or suffering are great enough, the individual can continue to feel the anxiety and fear for a long period even after the actual threat has been removed (Calhoun & Tedeschi, 1999, 2000). Sadness and depression are also common responses to traumatic events. An example of this would be if someone were to lose a loved one, they would feel “sadness, yearning for the deceased, and a general wish that things were different” (Wortman & Silver, 2001). Guilt, anger, and irritability are other feelings commonly observed after a life crisis (Wortman & Silver, 2001).

Sustained stress can lead a person to feel anxiety, frustration, anger, a feeling of losing control, or fatigue. These symptoms could be detrimental to a Soldier in combat. Fatigue could add to the problems of lack of sleep that Soldiers are experiencing during combat. Frustration can be compounded by the complexity of the current battlefield’s operations. A feeling of loss of control can become dangerous when a Soldier is given a weapon and placed in an ambiguous situation. These symptoms of sustained stress can lead to sleep deprivation, overeating, alcohol abuse, smoking, or other unhealthy ways to relieve stress. Combined, the effects of stress on the body is known as allostatic load (McEwen & Wingfield, 2003).

In addition to behavioral effects on a person, a person will also experience biological and neural changes during periods of increased stress. When an individual undergoes stress, the body attempts to moderate the effect of the stress through the autonomic, neuroendocrine, and immune systems. These moderators will respond to different types of challenges in different ways (Selye, 1956). The first response that results from stress is the “fight or flight” response. This response includes the activation

of the immune system, energy mobilization, and memory enhancement to identify the danger and avoid it later (McEwen, 2006). The goal of this response of the body is to return to allostasis. Allostasis is defined as “achieving stability through change” (McEwen, 1998; McEwen & Stellar, 1993).

The chemistry in the brain is also significantly affected by stress. Stress will change the chemistry of the brain and may even change brain circuitry. Both chronic stress and acute stress can influence neuroanatomical and neurochemical changes in the brain. The effects of the neuroanatomical and neurochemical changes in the brain can include increased anxiety, memory loss, altered judgment, or hypersensitivity to drugs and alcohol (Southwick, Ozbay, Charney, & McEwen, 2008). Once again, the anxiety, and especially the altered judgment, could have significant negative consequences for a Soldier in combat. These negative effects are likely due to the physical changes that occur in the limbic system, which includes the hypothalamus, amygdale, hippocampus and the prefrontal cortex.

The hippocampus receives inputs from other parts of the brain and regulates physical processes including the response to stress. The amygdale mediates a person’s response to stress through autonomic and hormonal responses (LeDoux, 1996). McEwen and Chattarjii (2004) found that the amygdale actually undergoes physical changes in response to both chronic and acute stress. This may include some dendrites retracting from sites and other dendrites creating new connections. The hippocampus works in coordination with the amygdale to store memories about an emotional experience. The hippocampus, like the amygdale, undergoes structural changes in response to stress. This

can include an increase and decrease in the branching of dendrites in the hippocampus (McEwen, 1999).

The prefrontal cortex controls the autonomic and neuroendocrine response to stress. The prefrontal cortex also helps a person with executive control and shifting attention (Damasio, 1997). Stress also affects the prefrontal cortex with structural remodeling leading to a decrease in performance in mental flexibility and attention shifting tasks (Liston et al., 2006; Radley et. al., 2005; Wellman, 2001).

Resilience and Posttraumatic Growth

The prefrontal cortex is an important aspect to consider when attempting to understand why individuals are resilient. Resilience deals with an individual's ability to adjust and recover quickly from the effects of stress. The construct of resilience is not defined effectively in terms of its main contributing factors. Even so, it is clear that resilience promotes effective adjustment to adversity in an individual. By studying different aspects of resilience, researchers can better understand the characteristics and coping strategies that allow some individuals to avoid the potentially debilitating effects of extreme stress and trauma.

According to Campbell, Campbell, & Ness (2008), resilient individuals may have a better assessment of the situation, thus allowing the individual more time to determine the best course of action to reduce the effects of the stressor. Furthermore, resilient individuals may be better at the decision making stage of the process. This may help these individuals to consider alternative decisions and increase the level of improvisation in the process. In addition, a resilient individual might also be able to increase their skills and abilities because they can continue to perform a task with a sense of purpose and

meaning and not be stopped by fear. Finally, resilient individuals may be better able to have a positive outcome to a situation because they have a goal centric and more realistic approach to the action and performance process. This is important to consider when studying resiliency, because it may be evidence that resilience can be taught.

In a study of post-bereavement spouses, the resilient individuals were the ones who were characterized as experiencing less enduring grief symptoms after the loss of a loved one (Bonanno et al., 2002). Researchers also discovered that resilient individuals scored higher on indices of global adjustment, work and social adjustment, and psychological and physical health adjustment (Klohn, 1996). After the attacks that took place on September 11, 2001, self reported resilient people stated that they felt more positive emotions in response to the event than negative emotions. These emotions were associated with a reduced incidence of depression (Fredrickson, Tugade, Waugh, & Larkin, 2003).

There are two things to consider when discussing resilience, and any other result of stress. They are anticipation and recovery. When a person anticipates a negative event it affects that individual in a less negative way than if that event was unexpected. The factors of anticipating stress are perceived certainty, controllability, and confidence in coping. The higher each factor, the more resilient to a stressful event the individual will be.

Recovery is the process by which individuals who have experienced negative effects of stress or adversity gradually and eventually return to their original levels of functional and emotional well being (Fredrickson et al., 2003). There are many coping strategies that an individual may use to recover from a stressful event. The better a

person's recovery rate is, the higher their resilience can be expected to be. Although recovery and resilience are two different things, they correlate with each other. A more resilient individual will anticipate and recover faster from a stressful event than an individual with a lower resilience.

Another factor that can determine resilience is personality. Two broad categories that describe possible actions in the face of stress are flexible adaptation and pragmatic coping (Bonanno, 2004). Flexible adaptation can operate through a variety of cognitive, emotional, and interpersonal processes, but its common denominator is the capacity to shape and modify one's behavior to meet the demands of the given stressor. Pragmatic coping is a "whatever it takes" response to traumatic events that are referred to as "coping ugly" (Bonanno, 2008). It involves single-minded goals directed at coping strategies that evoke many of the meanings that define the word pragmatic. Experiencing positive emotions help to assist a higher level of resilience in a person.

The tendency to hold positive expectations about the future is described as dispositional optimism (Scheier, Carver & Bridges, 1994). Individuals who are optimistic usually view negative events as being temporary, specific, and brought forth by external causes. The personality of an individual can be correlated to that same person's resilience. Resilience is usually more prominent in individuals with stronger personalities.

According to Bonanno (2004), most people do not display PTSD like symptoms when exposed to traumatic events. Bowlby (1980), a bereavement theorist, considers a positive reaction or no reaction to the loss of an important friend or relative as a symptom of denial. Zisook, Paulus, Shuchter, & Judd (1997) found that approximately half of the

sample of the adults examined showed little or no depression to the loss of a loved one or close friend. Furthermore, in a study conducted by Bonanno et al. (2002) data was gathered from a sample three years before the loss of a spouse. The researchers found that 46% of the sample showed little or no depression after the loss and through 18 months after the loss. Some of these participants did report that they missed the individual, but the difference between the resilient participants and non-resilient participants was that the effects were temporary and did not affect their everyday functioning.

In addition to resilience, another positive outcome of a traumatic event can be posttraumatic growth. When the concept of PTG was first introduced, it was used in an article describing the development of an inventory that was designed to measure growth. The early terms included perceived benefits, positive aspects, and the transformation of trauma (Calhoun & Tedeschi, 2000). Other terms used later included stress related growth (Park et al., 1996), positive byproducts (McMillen, Howard, Nower, & Chung, 2001), flourishing (Ryff & Singer, 1998), and discovery of meaning (Bower et al., 1998). Posttraumatic growth was finally adopted because it was felt that it captured the essentials of the phenomenon better than other terms (Calhoun & Tedeschi, 1999, 2000).

Folkman et al. (2000) suggest that coping theory has focused too much on the negative effects and reactions to stress. The researchers state that there is a lot to be learned from looking at the reaction to stress in a positive way and investigating the positive outcomes of traumatic events. Tedeschi & Calhoun (1996) found that extraverts and other personality traits could actually help a person to reframe or rethink about a traumatic event as a positive or growing experience. Tedeschi, Park, & Calhoun (1998) give the examples of positive support organizations such as Alcoholics Anonymous,

Mothers Against Drunk Driving, and Physicians for Social Responsibility as positive outcomes of traumatic events. Paton & Violanti (1996) found that individuals responded positively to traumatic events more than they responded with decreased functionality. This does not mean that the individual will not experience some type of psychological irregularity, but the individual will experience this irregularity at first and then return to their level of functionality they had before the traumatic event (McFarlane & Yehuda, 1996). Some individuals can even improve after a traumatic event. Some improvement areas found by research are changes in priorities, relationship improvement, changes in a person's philosophy on life, or a change in a person's perceived strengths (Folkman, & Tedlie Moskowitz, 2000; Tedeschi & Calhoun, 1996; Tedeschi, Park & Calhoun, 1998; Violanti, Paton, & Dunning 2000).

Posttraumatic growth occurs in Soldiers more often than PTSD or other negative effects of exposure to high levels of prolonged stress and traumatic events. PTG can be manifested in several ways. An individual experiencing PTG can show an increased appreciation for life in general, have more meaningful interpersonal relationships, an increased sense of personal strength, changed priorities, and a richer, more existential spiritual life (Calhoun & Tedeschi, 1999, 2000).

An event bringing a person close to death can make a person much more aware of the good things that they have in life. They will certainly be thankful for their opportunity to continue living. Identifying these symptoms is a new idea, although the theory that good can come from a bad event is one that has been around for ages (Calhoun & Tedeschi, 1999, 2000). There are several accounts of people experiencing PTG after traumatic events. Sally Walker, a geology professor who is the survivor of a

plane crash that killed 83 people shared some of her feelings. “When I got home, the sky was brighter...[Now] everything is a gift” (Calhoun & Tedeschi, 1999, 2000).

The words trauma, crisis and highly stressful events are terms that describe significant challenges to individuals’ adaptive resources and their way of understanding the world and their place in it (Janoff-Bulman, 1992). A Posttraumatic Growth Inventory (PTGI) was developed to allow for measurement of the growth experienced by people who have experienced a traumatic event (Tedeschi & Calhoun, 1996). The scale was developed from the various responses to stressful events based upon interviews done with people who had gone through the loss of a spouse, a physical disability, or another life crisis. The PTGI measures five domains of growth that were derived from the literature on responses to highly stressful events. Overall PTG occurs more often than PTSD in our military, but does not receive as much attention. Perhaps future studies on the positive outcomes of this stress can lead to a way to enhance resilience and growth from stress using interventions. This phenomenon is quite complex and should not be referred to as just a coping mechanism. The outcomes of PTG are considered to be iterative and will take longitudinal work to trace the varied trajectories of the process (Calhoun & Tedeschi, 1999, 2000).

Calhoun, Cann, Tedeschi, and McMillan (2000) studied the link between rumination and posttraumatic growth. The researchers found that there was a relationship between post event rumination and the amount of posttraumatic growth reported. The more rumination that people displayed after the event, the more posttraumatic growth that occurred. This will only occur if the rumination is positive, if negative rumination occurs;

it will decrease the amount of posttraumatic growth and can even increase the levels of distress.

It has been noticed that PTG tends to “surprise people” and has never really been a conscious goal of the individual. Because of this, it is emphasized that PTG is the result of attempts by the individual to reestablish some useful, basic cognitive guides for living, as opposed to an attempt to manage the terror of mortality (Davis & Nolen-Hoeksema, 2001).

It is important that the military identify not just at risk Soldiers, but Soldiers that show resilience. According to Garb and Cigrang (2008), early screening begins at recruitment stations where interested applicants fill out a medical prescreening form. However, this form has only one question about psychiatric disorders and the question asks whether the person has seen a mental health professional for any reason. The problem with this question is that many people that have mental health issues have never seen a mental health professional. Furthermore, applicants that are in desperate need for a job will probably not volunteer this information.

The Army Research Institute also initiated a program to test non-high school graduates entering the Army. Individuals entering the Army with a GED were also given the Assessment of Individual Motivation (AIM). This assessment tested individuals on their personality traits, such as being motivated to succeed, having a positive outlook on life, and interacting peacefully with others (White & Young, 1998). The researchers at found that lower scores on the AIM resulted in a higher rate of attrition in the first-term of the recruit’s service. However, the Human Resources Research Organization and

independent consultants found the assessment to be less valid than what was first indicated in the Army Research Institute's research (Knapp, Heggstad, & Young, 2004).

MEG

The proposed study will seek to build on some of the tests and interventions that are already established. It is important that this study be integrated into the Comprehensive Soldier Fitness program. The proposed study is based on research conducted by Georgopoulos, Tan, Lewis, Leuthold, Winskowski, Lynch, & Engdahl (2010) that examined the synchronous neural interactions test as a functional neuromarker for PTSD by using a bootstrap analysis based on Magnetoencephalography (MEG) readings.

MEG is a non-invasive technique for measuring neural activity in the brain. The sites that are activated in the brain can be determined by their magnetic-field distribution. These magnetic signals are measured using a multichannel superconducting quantum interference device (SQUID) (Hamalainen et al., 1993). Hamalainen et al. (1993) found that MEG devices have a time resolution of better than 1ms and a spatial discrimination of 2-3mm. This is compared to functional Magnetic Resonance Imaging (fMRI) which has a temporal resolution of 100 ms and a spatial resolution of 1-2 millimeters (Posse et. al., 1996). The advantages to using MEG is that traditionally this data is used to analyze the underlying neuronal activity whereas, a device like EEG is used to analyze patterns of electrical potentials across the scalp (Williamson et. al., 1991). The MEG is better at finding the neuronal source because it uses the magnetic signal instead of the electrical signal that is easier to model around the head (Williamson et. al. 1991).

According to DeFina (2009) a functional neuromarker is the metabolic, electrical, and chemical signatures that underlie brain injury. The purpose of the Georgopoulos et. al. (2010) study was to find a neuromarker that would allow the researchers to categorize participants into a PTSD group or healthy group. Participants included a PTSD group that was selected from a group of veterans from Minnesota and Wisconsin. These veterans all had one or more contacts with the Minneapolis VA medical center. The clinical records of all of the participants in the PTSD group were diagnosed by interviews based on the CAPS or DSM-IV-TR SCID PTSD models. Interested PTSD participants underwent further analysis. Only 74 participants were selected that had confirmed PTSD as the primary symptom based on clinical interviews. Participants who showed instability within 6 months of the experiment or who had other psychotic disorders based on their medical records were screened from the study. In addition, patients with substance abuse disorders, central nervous system disorders, or severe pain were also not selected. Sixty-nine of the participants were male with the mean age being 52.2 ± 1.77 years and five women were selected with a mean age of 46.2 ± 4.12 years. Fifty-six of the participants were receiving medications for their psychiatric disorders at the time of the study. The control subject group consisted of 250 healthy participants. One hundred fifty-one of these patients were men with a mean age of 52.2 ± 1.3 years and 99 were women with a mean age of 49.9 ± 1.6 years. These participants were interviewed and the researchers evaluated their medical history to ensure they had no psychiatric disorders.

The researchers used a MEG and a simple fixation task to keep the activity of the brain stable. Participants lay on their back in the electromagnetically shielded chamber

and fixated on a spot 65c, from their face for one minute. Once the researchers collected the data from the MEG, a bootstrap approach was used to classify the different participants. This approach seeks to categorize a participant given a group of known classification. This approach does not simply evaluate the category of a participant on a single run, but takes into account the variability of both the control and PTSD groups which gives a more realistic and practical classification of the participant. The researchers in this study found that the accuracy of the classification was >90%. In addition, of the 18 non-medicated PTSD patients, 17 (94.4%) were categorized correctly. For the remainder of the 56 PTSD patients, 55 (98.2%) were categorized correctly. If $h^s=1$ it means that the prediction of the participant has the highest certainty of the prediction that is possible. Overall, $h^s=1$ for 184 out of the 324 (58.3%) participants. For the control group, $h^s=1$ for 155 of the 250 (62%) and for the PTSD group, $h^s=1$ for 34 out of 74 (45.9%) of the participants. The researchers also investigated the potential for classifying the severity of PTSD in participants. A quantitative index of PTSD was given to 50 patients. The analysis divided the participants into two subgroups, the group with $h^s=1$ and $h^s<1$. The researchers found that the PTSD severity index was higher for the group with $h^s=1$ than for participants with a $h^s <1$. The average PTSD severity index was a lot higher in the 21 subjects with the most certain classifications of PTSD. This shows that there is a significant positive association between the certainty of prediction and the severity of the symptoms.

The accuracy of the synchronous neural interactions (SNI) test as a functional neuromarker for PTSD suggests that there is a distinct difference in the synchronous

neural interactions between PTSD and those without PTSD. This test offers a promising method for monitoring the progression of PTSD, evaluating the severity of PTSD, and the effects of interventions.

Proposed Study Method

Participants

Soldiers participating in the CSF program as well as those who currently are not will be tested and include Soldiers diagnosed with PTSD as well as a control group of Soldiers that do not have PTSD. Similar to the Georgopoulos et. al. (2010) study, there will be a greater number of control participants when compared to PTSD participants.

Apparatus and Procedure

If the MEG can be better refined to identify the specific differences between a person with PTSD and a person without PTSD this may reveal a way to create resilience to PTSD through the use of interventions. This method could be integrated into the Combat Soldier Fitness (CSF) study, as a measure of the success of the program. Researchers could use the MEG method to measure Soldiers before they take the CSF, during the CSF course and even after the CSF. Since CSF is also concerned with the long term effects of the CSF program, the MEG method could be used to investigate the status of Soldiers six months and a year after Soldiers have taken the CSF course.

Conclusion

The research conducted by Georgopoulos et al. (2010) offers a promising avenue to give an objective diagnosis of PTSD and the potential to evaluate the effectiveness of interventions. A surprisingly high correct classification rate was obtained for patients of

PTSD who were not medicated. These results indicate that SNI testing can be very useful for diagnosis and monitoring disease progression.

The proposed study presents an interesting way to get an objective measure of the development of PTSD in an individual. The focus has primarily been on subjective measures for the diagnosis of PTSD, but this would allow doctors and commanders to validate a diagnosis. This may also reduce the stigma that now exists against seeing a mental health practitioner by creating a more acceptable way of obtaining a diagnosis of PTSD. This could be similar to getting an X-ray for a broken arm or leg. In turn this may potentially increase the number of Soldiers receiving the help that they need and reduce the number of false positive diagnoses. Soldiers could go to a hospital and have an objective test of whether they have PTSD or not. An MEG measurement has the potential to alleviate any ambiguity in diagnosing Soldiers who may not have PTSD, but are displaying the symptoms of the disorder.

What is particularly salient about the potential results of the study is if the severity of PTSD predictions can be better refined. If a classification system is created to identify where on the spectrum of PTSD severity a Soldier resides, then researchers can have an objective measurement of the progress of interventions. This could provide objective evidence that certain interventions are actually improving Soldiers' mental health or indicate that some interventions are not working.

Annotated References

Bartone, P. T. (1999). Hardiness protects against war-related stress in Army Reserve forces. *Consulting Psychology Journal*, 51(2), 72-82.

This article examines the effects of increased stress to National Guard and reserve units. The author focused on the hardiness of reserve units deployed in the Persian Gulf War as a potential protective characteristic against the development of PTSD. The results of the study showed hardiness to interact with combat-related stress and traumatic events to predict psychiatric symptoms. The author concluded that hardiness did actually protect Soldiers against the effects of stress.

Bonanno, G. A. (2004). Loss, trauma, and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist*, 59(1), 20-28.

This article investigates the positive outcomes of stress and traumatic events. The author challenges most of the present literature on loss and traumatic events that focus on the negative effects of traumatic events. It is argued that positive outcomes actually happen more often than negative effects to traumatic events. In addition, the author argues that there are multiple ways for people to reach resilience.

Bonanno, G.A., & Mancini, A.D. (2008). The human capacity to thrive in the face of potential trauma. *Pediatrics*, 121(2), 369-375.

The authors discuss potential outcomes of traumatic events as well as factors that either promote (e.g., social support and coping strategies) or hamper resilient outcomes (e.g., life stressors prior to and following the traumatic event). Four possible outcomes include: delayed reactions to the event, resilience, recovery, and chronic dysfunction.

Bonanno, G. A., Wortman, C. B., Lehman, D. R., Tweed, R. G., Haring, M., Sonnega, J., et al. (2002). Resilience to loss and chronic grief: A prospective study from pre-loss to 18 months post-loss. *Journal of Personality and Social Psychology*, 83, 1150-1164.

This study examined 205 individuals years prior to losing a spouse. The researchers then followed the individuals six to eighteen months after they lost a spouse. The researchers discovered that there are five different patterns in which subjects mourned after the loss of a spouse. The five different patterns were: common grief, chronic grief, chronic depression, improvement during bereavement, and resilience.

Bower, J. E., Kemeny, M. E., Taylor, S. E., & Fahey, J. L. (1998). Cognitive processing, discovery of meaning, CD 4 decline, and AIDS-related mortality among bereaved HIV-seropositive men. *Journal of Consulting and Clinical Psychology*, 66, 979–986.

This study investigated whether finding meaning in response to an HIV-related stressor was associated with changes in immune status and health. The results suggest that positive responses to stressful events, specifically the discovery of meaning, may be linked to positive immunologic and health outcomes.

Bowlby, J. (1980). *Loss: Sadness and depression: Vol. 3. Attachment and loss*. New York: Basic Books.

This book focuses on the emotional response to loss. This includes feelings of sadness, depression, grief, and bereavement. Bowlby created a four-stage model of grief.

Calhoun, L. G., Cann, A., Tedeschi, R. G., & McMillan, J. (2000). A correlational test of the relationship between posttraumatic growth, religion, and cognitive processing. *Journal of Traumatic Stress*, 13(3), 521-527.

This study investigated the relation between rumination and a person's religious involvement. The researchers used the Quest Scale, a combination of religious participation and the Posttraumatic Growth Inventory, to measure fifty-four young adults before a traumatic event. The researchers found that the degree of openness to religion was related to posttraumatic growth.

Calhoun, L. G., & Tedeschi, R. G. (1999). *Facilitating Posttraumatic Growth: A Clinician's Guide*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

This book is about different ways for clinicians to aid and foster posttraumatic growth. The methods of doing so include understanding the way men and women grieve grief therapy, therapeutic interventions, suicide awareness, and encountering dying and death. By understanding each of these metrics, clinicians can better assess and help guide the progression of their patients.

Campbell, D., Campbell, K., & Ness, J. W. (2008). Resilience through leadership. In B. J. Lukey & V. Tepe (Eds.), *Biobehavioral Resilience to Stress* (pp. 57-90). Boca Raton, FL: CRC Press.

This chapter examines the effects that leadership can have on resilience. First, the authors explain basic leadership theory to include the general nature of leadership, behavior of effective leaders, and the way to influence subordinates. The authors then investigate the potential for leaders to effect both an individual's and group's resilience to stress.

CBS News. (2008, May 27). New cases of PTSD soar among Soldiers.

This news article discusses the number of PTSD diagnosis between 2003 and 2008. The article states that there were 40,000 cases diagnosed between these years, but some Army generals believe that the number is actually higher. Some of Soldiers go to private providers, but the reason for most of the cases is the increased exposure to combat.

Damasio, A. R. (1997). Towards a neuropathology of emotion and mood. *Nature*, 386(6627), 769-770.

This article examines various studies of mood disorders and abnormalities and these include an MRI study, a study on the localization of subgenual prefrontal cortex abnormalities, and a positron emission tomographic image study.

Davis, C.G., & Nolen-Hoeksema, S. (2001). Loss and meaning: How do people make sense of loss? *American Behavioral Scientist*, 44, 726-741.

Participants in this study were interviewed pre-and post-loss of a terminally ill loved one to determine how or whether they find meaning out of the situation. Meaning was found based on religious/spiritual beliefs, consistency with the family member's perspective on life and the predictability of the loss. If the loss fit with the family member's view of the world, then they were better able to make sense of the loss and if unable to make sense of the loss within the first six months, they generally did not make sense of the loss later.

DeFina, P. A. (2009). Functional imaging neuromarkers guide non-invasive neuromodulation in brain injury: An integrated multimodal approach to assessment and rehabilitation (11). (Doctoral dissertation, International Brain Research Foundation, Inc. 2009). 11. Retrieved May 6, 2010, from http://www1.va.gov/RAC-GWVI/docs/Minutes_and_Agendas/Minutes_June2009_Appendix_Presentation11.pdf

In this presentation that was given by Dr. DeFina titled "Bringing Brain Science to Life," Dr. DeFina discusses neuroimaging techniques to investigate levels of arousal and functional neuromarkers for traumatic brain injury. He also discusses modeling traumatic brain injuries with neuromarkers. He discusses various methods of obtaining this data such as EEG, fMRI, and MEG. These methods are all used to understand the neuromarkers of traumatic brain injury.

Folkman, S., & Tedlie Moskowitz, J. (2000). Positive affect and the other side of coping. *American Psychologist*, 55(6), 647-654.

This article addresses the lack of research dedicated to positive outcomes of traumatic events. The researchers investigated the positive outcomes that can occur after repeated exposure to stress.

Fredrickson, B.L., Tugade, M.M., Waugh, C.E., & Larkin, G.R. (2003). What good are positive emotions in crises? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *Journal of Personality and Social Psychology*, 84(2), 365-376.

University of Michigan students who participated in a study of emotions prior to 9/11 were contacted after 9/11 to assess whether or not positive emotions serve as a buffer against depression and if positive emotions aid in a person's ability to thrive (e.g., an increase in one's satisfaction with life and optimism). The findings supported the hypotheses which are consistent with the broaden-and-build theory of positive emotions.

Garb, H. N., & Cigrang, J. (2008). Psychological Screening: Predicting Resilience to Stress. In B. J. Lukey & V. Tepe (Eds.), *Biobehavioral Resilience to Stress* (pp. 3-24). Boca Raton, FL: CRC Press.

This chapter investigates the Army's method for screening new recruits. The purpose of the chapter was to investigate ways to make prescreening better in order to better predict whether a person will make it through basic training. The authors first investigate the background of Army prescreening. At the end of the chapter, the researches investigate current trends in the field to create new instruments and procedures.

Georgopoulos, A. P., Tan, H. M., Lewis, S. M., Leuthold, A. C., Winkowski, A. M., Lynch, J. K., & Engdahl, B. (2010). The synchronous neural interactions test as a functional neuromarker for post-traumatic stress disorder (PTSD): A robust classification method based on the bootstrap. *Neural Engineering*, 7, 1-7.

The authors investigated the idea of finding a biomarker for PTSD using a synchronous neural interactions (SNI) test from data captured from magnetoencephalogram (MEG) recordings. The researchers found that they could differentiate between PTSD patients and healthy patients with >90% accuracy.

Hamalainen, M., Hari, R., Ilmoniemi, R. J., Knuutila, J., & Lounasmaa, O. V. (1993). Magnetoencephalography-theory, instrumentation, and applications to noninvasive studies of the working human brain. *Reviews of Modern Physics*, 65(2), 413-497.

This study investigates the technique of using MEG in research. The authors report that the time resolution is better than 1 ms and the spatial resolution is 2-3mm. MEG data is collected by a superconducting quantum interference device (SQUID). The authors explain the neural and mathematical theory behind using and evaluating the MEG machine. The authors then describe some experiments done in their lab to give an example of how the machine is used.

Hoge, C., Auchterlonie, J. & Milliken, C. (2006). Mental health problems, use of mental health services, and attrition from military service after returning from deployment to Iraq or Afghanistan. *Journal of the American Medical Association*, 295, 1023-1032.

This study focused on veterans PTSD care within the first year of returning from a deployment. The correlation between the results of screening, use of mental health services, and attrition from the military was investigated. The researchers found that mental health problems were reported 19.1% of Soldiers returning from Iraq, 8.5% after returning from Afghanistan and 8.5% after returning from other locations. The researchers indicated that these results display a lack of mental-health care resources provided for Soldiers in Iraq.

Janoff-Bulman, R. (1992). *Shattered assumptions*. New York: The Free Press.

This book examines how people deal with traumatic events and how their world views impact their reactions to these events. The author discusses three assumptions that are at the core of their experience and include one's belief that she or he is worthy, the belief that the world is benevolent and the belief that the world is meaningful.

Klohn, E.C. (1996). Conceptual analysis and measurement of the construct of ego-resiliency. *Journal of Personality and Social Psychology*, 70(5), 1067-1079.

This study examined the discriminant and convergent validity, external validity, psychometric properties of ego resiliency (ER). "ER is a personality resource that allows individuals to modify their characteristic level and habitual mode of expression of ego-control so as to most adaptively encounter, function in, and shape their immediate and long-term environmental contexts."

Knapp, D. J., Heggstad, E. D. & Young, M. C. (2004). *Understanding and Improving the Assessment of Individual Motivation (AIM) in the Army's GED Plus Program*. Alexandria, VA: United States Army Research Institute for the Behavioral and Social Sciences.

The AIM is an important tool that is used by the army to assess individuals of important work-related temperaments. The authors examined the usefulness of the AIM's use in the GED plus program. This study found that the AIM's uses in the GED plus program that the validity of AIM is actually lower than previous studies have indicated.

LeDoux, J. E. (1996). *The Emotional Brain: The Mysterious Underpinnings of Emotional Life*. New York: Simon & Schuster.

This book examines the process the brain goes through to create emotions. LeDoux concludes that the amygdale has two main functions “to store any novel physical body state with its associated perceptual context, and when presented with a familiar perceptual context later, to re-trigger its associated physical body state.”

Liston, C., Miller, M. M., Goldwater, D. S., Radley, J. J., Rocher, A. B., Hof, P. R. et al. (2006). Stress-induced alterations in prefrontal cortical dendritic morphology predict selective impairments in perceptual attentional set-shifting. *Journal of Neuroscience*, 26(30), 7870-7874.

This study examines the possibility that structural damages in the medial prefrontal cortex and the orbital frontal cortex underlie behavioral abnormalities. The authors used rats under 21 days of repeated stress to complete an attentional set-shifting task. The researchers found that chronic stress produced a 20% retraction of dendrites in the rats.

McEwen, B.S. (2006). Protective and damaging effects of stress mediators: central role of the brain. *Dialogues in Clinical Neuroscience*, 8(4), 367-381.

This study focused on the many everyday stressors that can build up and cause the body to undergo a constant effort to suppress the negative effects of stress. This can lead to unhealthy behaviors such as lack of sleep and overeating. This study also discusses the concept of allostatic load and how the brain attempts to return to allostasis.

McEwen, B. S. & Chattarji, S. (2004). Molecular mechanisms of neuroplasticity and pharmacological implications: The example of tianeptine. *European Neuropsychopharmacology*, 14(Suppl. 5), S497-S502.

This study investigates the effect of stress on the hippocampus. It also investigates the effect of stress on the amygdale. Specifically, the increased fear learning and changed behavior that occurs with continued stress.

McEwen, B.S. & Wingfield, J.C. (2003). The concept of allostasis in biology and biomedicine. *Hormones and Behavior*, 43(1), 2-15.

This study investigates the concept of allostasis and allostatic load. Allostasis is defined in this study as “the cumulative cost to the body of allostasis” and allostatic overload is “a state in which serious pathophysiology can occur.” The researchers proposed two types of allostatic overload. One in which where energy demands exceeds supply and the other type is where there is adequate energy, but there is also social conflict.

McEwen, B. S. (1999). Stress and hippocampal plasticity. *Annual Review of Neuroscience*, 22, 105-122.

This study focused on the effect of stress on the hippocampus. Specifically the study focuses on the fact that stress can actually cause atrophy of dendrites in the CA3 region and regulate gyrus volume during development and in adult life.

McEwen, B.S. (1998). Seminars in medicine of the Beth Israel Deaconess Medical Center: Protective and damaging effects of stress mediators. *New England Journal of Medicine*, 338(3), 171-179.

This study investigated the long term effects of stress on the body. Specifically the researcher investigated the physiological response to stress and introduced the concepts of allostatic load and allostasis. Allostasis in this study is defined as “the ability to achieve stability through change.”

McEwen, B.S. & Steller, E. (1993). Stress and the individual: Mechanisms leading to disease. *Archives of Internal Medicine*, 153(18), 2093-2101.

This study examines the relationship between stress and the development of diseases. The study highlights the long term effects of stress on the body which can affect the reaction to acute stressful events.

McFarlane, A. C., and Yehuda, R. (1996) Resilience, vulnerability and the course of posttraumatic reactions. In B. van der Kolk, A. McFarlane, & L. Weisaeth, (Eds.). *Traumatic Stress: The effects of Overwhelming Experience on Mind, Body, and Society*. (pp. 155-181). New York: Guilford Press.

This book examines the effects of PTSD on a person in regards to their biology, conception of the world, and psychological functioning. The authors examine the neurobiological explanation of why some people deal with PTSD better than others do.

McGrath, J. (1976). Stress and behavior in organizations. In: Dunnette, M. D. (Ed.), *Handbook of Industrial and Organizational Psychology* (pp. 1351-1395). Chicago, IL: Rand McNally.

In this chapter, the researcher develops a four stage cycle of processing stress. The four stages include appraisal, decision-making, performance, and outcome. A person will first appraise the situation and determine if the stress will lead to negative outcomes if left unchecked. Next, the individual will choose a course of action. After a course of action is selected, a person will evaluate the results of their action.

McMillen, C., Howard, M. O., Nower, L., & Chung, S. (2001). Positive by-products of the struggle with chemical dependency. *Journal of Substance Abuse Treatment*, 20, 69–79.

This study looks at focus groups that were conducted to identify ways persons in recovery from chemical dependence think they have benefited from their struggles with addiction. Ways to incorporate knowledge about these positive by products into the substance abuse treatment programs are introduced as well.

Park, C. L., Cohen, L., & Murch, R. (1996). Assessment and prediction of stress-related growth. *Journal of Personality*, 64, 71–105.

This article reports the development of the Stress Related Growth Scale (SRGS) and its use in a study examining determinants of stress related positive outcomes for college students. The SRGS is also positively related to residual change in optimism, positive affectivity, number of socially supportive others, and social support satisfaction, which lends further support to the validity of this scale.

Paton, D., & Violanti, J. (1996). *Traumatic stress in critical occupations; recognition, consequences and treatment*. Illinois: Charles C. Thomas.

This book examines a person's response to a traumatic event and the social and organizational background. The purpose of the book is to understand stress and trauma and building a trauma management system.

Posse, S., Muller-Gartner, H., & Dager, S. R. (1996). Functional magnetic resonance studies of brain activation. *Seminar for Clinical Neuropsychiatry*, 1(1), 76-88.

This article investigates the new advances in fMRI technology and ways to apply this technique to study the human brain. The authors do note that fMRI results are not as promising as they appear at first because the fMRI method is based on some assumptions. The authors discuss the possibility of combining fMRI with functional magnetic resonance spectroscopy and functional magnetic resonance spectroscopic imaging techniques to achieve better results.

Radley, J. J., Rocher, A. B., Janssen, W. G. M., Hof, P. R., McEwen, B. S. & Morrison, J. H. (2005). Reversibility of apical dendritic retraction in the rat medial prefrontal cortex following repeated stress. *Experimental Neurology*, 196(1), 199-203.

This article discusses dendritic retraction and synapse in the prefrontal cortex in response to stress. This research subjected animals to three different conditions. The first group received three weeks of constant stress, group two received three weeks of stress followed by three weeks of recovery before testing, and the third group received no stress. The researchers found that group one had a significant reduction in dendritic growth compared to the group that received rest. The authors concluded that stress induced reduction in dendritic growth can be reversible.

Ritchie, E. C., Schneider, B., Bradley, J., & Forsten, R. D. (2008). Resilience and military psychiatry. In B. J. Lukey & V. Tepe (Eds.), *Biobehavioral Resilience to Stress* (pp. 25-42). Boca Raton, FL: CRC Press.

This chapter attempts to investigate the current status and practices in military psychiatry. The authors first explain the history of combat psychiatry. The authors then discuss the current trends in stress management, prevention, and treatment of combat stress throughout a deployment. The chapter ends with the strategies when Soldiers are evacuated for psychiatric reasons.

Ryff, C. D., & Singer, B. (1998). The role of purpose in life and personal growth in positive human health. In P. T. P. Wong & P. S. Fry (Eds.), *The Human Quest for Meaning: A Handbook of Psychological Research and Clinical Applications* (pp. 213–235). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

This chapter looks at several studies of people coping with loss or trauma and concludes that posttraumatic growth is common. There have been many recent studies that suggest that the reports of growth are illusory. Two experiments were conducted involving 89 college students. The results from the first show that a traumatic episode leads to one more strongly affirming that their life is meaningful relative to a control group. The second experiment indicates that reminders of death lead people to exaggerate the extent to which their life seemed meaningful.

Scheier, M.F., Carver, C. S., & Bridges, M.W. (1994). Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, 67(6), 1063-1078.

College students were studied with regard to their dispositional optimism as measured by the Life Orientation Test. Individuals who are optimistic usually view negative events as being temporary, specific, and brought forth by external causes. Optimism was correlated with lower depression scores and less use of maladaptive coping strategies.

Selye, H. (1956). *The Stress of Life*. New York: McGraw-Hill.

The purpose of this book was to evaluate the understanding of stress on the human body as it has evolved through research. Selye explained the biological effects and the counter measures enacted by the body to fight against the effects of stress.

Southwick, S. M., Ozbay, F., Charney, D., & McEwen, B. S. (2008). Adaption to stress and psychobiological mechanisms of. In B. J. Lukey & V. Tepe (Eds.), *Biobehavioral Resilience to Stress* (pp. 91-115). Boca Raton, FL: CRC Press.

This chapter discusses the behavioral and physiological responses to stress. The authors discuss what occurs during “good” stress, as well as “bad” stress. The author implies that the duration of the stress may determine whether it is good or bad. This chapter focuses on the brain structures, processes, and mechanisms that occur when a person is under stress.

Tedeschi, R. G., Park, C. L., and Calhoun, L. (Eds) (1998). *Posttraumatic Growth: Positive Changes in the Aftermath of Crisis*. New Jersey: Lawrence Erlbaum Associates.

This book focuses on post traumatic growth after an event. The authors cite positive supports organizations such as Alcoholics anonymous, Mothers Against Drunk Driving, and Physicians for Social Responsibility as positive outcomes of traumatic events.

Tedeschi, R. G., and Calhoun, L. G. (1996). The Posttraumatic Growth Inventory: Measuring the positive legacy of trauma. *Journal of Traumatic Stress*, 9 (3), 455-471.

This study examines the validity of the Posttraumatic Growth Inventory. The inventory includes factors like new possibilities, relating to others, personal strength, spiritual change, and appreciation of life. The researchers found that women and people that experience a traumatic event display more positive change than any other groups.

Violanti, J. M., Paton, D. and Dunning, C. (Eds.) (2000). *Posttraumatic Stress Intervention: Challenges, Issues and Perspectives*. Springfield, IL: Charles C. Thomas.

This study focuses on investigating other methods of dealing with PTSD besides posttraumatic event psychological debriefings. This study addresses the need for more alternatives to thinking about the relationship between people and traumatic events. Thinking about the interaction with traumatic events may lead to interventions that will mitigate traumatic stress reactions, develop resilience and establish necessary individual and organizational resources.

Wellman, C. L. (2001). Dendritic reorganization in pyramidal neurons in medial prefrontal cortex after chronic corticosterone administration. *Journal of Neurobiology*, 49(3), 245-253.

This study examined the alterations of dendrites in the prefrontal cortex and how these alterations are linked to impaired working memory, altered emotions, and inability to regulate hypothalamic-pituitary adrenal activity. The researchers used animals that received 3 weeks of stress and then a three week recovery period, 3 or 6 weeks of stress, or no stress. The researchers reported a significant reduction in dendrite growth in the group that received 3 to 6 weeks of stress compared to the group that received rest. The researchers concluded that the reduction of dendrites could be reversed.

White, L. A. & Young, M. C. (1998). Development and validation of the Assessment of Individual Motivation (AIM). Paper presented at the annual meeting of the American Psychological Association, San Francisco, CA.

The authors discuss the development of the Assessment of Individual Motivation (AIM). The authors explain that the assessment gathers information on individuals related to personality traits, specifically, these traits ensure that a person can effectively work in an environment with other people. The researchers found that lower scores on the AIM are associated with lower attrition rates in the first term of entering the Army.

Williamson, S. J., Lu, Z., Karron, D., & Kaufman, L. (1991). Advantages and Limitations of Magnetic Source Imaging. *Brain Topography*, 4(2), 169-180.

In this article the researchers discuss the definition of magnetic source images (MSI) and how MEG is used to record the neuronal activity of the brain. The author discusses the innovations in the MSI that allow for more in-depth views of the brain's activity. The authors also mention that one of the major downsides to this equipment is the high cost to purchase and operate.

Wortman, C. B., & Silver, R. C. (2001). The myths of coping with loss revisited. In M. S. Stroebe, R. O. Hansson, W. Stroebe, & H. Schut (Eds.), *Handbook of Bereavement Research: Consequences, Coping and Care* (pp. 405-429). Washington, DC: American Psychological Association.

This article deals with the issues of coping with grief. Coping with grief can include either trying to assimilate the loss into the existing worldview and its spiritual components or changing those components in congruence with the new reality. Clinicians who work with bereaved persons need to be aware of the possibility that such themes may be important to their clients. This article lends some suggestions that can assist clinicians in this kind of work.

Zisook, S., Paulus, M., Schuchter, S. R., & Judd, L. L. (1997). The many faces of depression following spousal bereavement. *Journal of Affective Disorders*, 45, 85-94.

This study examines the episodes of major, minor, and subsyndromal depressions in widows. The study examined 328 widows from 2 to 25 months after the widow had lost their spouse. The researchers found that if the widow has depression before losing a spouse they would have worse depression after they lose their spouse. If the widow has unipolar depression, the widow will have worse unipolar depression. The author concluded that major, minor, and subsyndromal depressions are actually manifestations of the same unipolar depression disorder.